Journal of Archaeological Science 52 (2014) 108–115

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

The utilisation of carnivore scavenging evidence in the interpretation of a protohistoric French pit burial

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ARTICLE INFO

Article history:
Received 20 March 2014
Received in revised form
1 August 2014
Accepted 11 August 2014
Available online 23 August 2014

Keywords:
Scavenging
La Tène
Action burial
Excarnation
MSCT
ESEM

ABSTRACT

Scavenging is one of the main taphonomic changes that bone assemblages undergo. This paper presents specific taphonomic data on bone modification by canids from the French archaeological site of Duisans 'La Sèche-Epée,' dating from the 'La Tène A' period (500–400 BC). Anthropological description and analysis of two incomplete male skeletons found in a pit allows us to document the postmortem alteration of bodies by canid scavengers and poses several questions about the nature of the deposit. The morphology of these marks, which are sometimes similar to antemortem lesions, and the disarticulation and dispersal of anatomical parts are crucial elements that need to be accurately described and accounted for in archaeological or forensic contexts. The evidence of violent death and the secondary treatment of the cadavers can be interpreted as either an opportunistic votive burial, an actual sacrifice with a specific ritual pattern, or more traditionally, a deviant deposit in which the individuals were deprived of funerals and exposed to scavengers.

1. Introduction

Carnivore scavenging is one of the postmortem taphonomic changes traditionally documented for human remains in forensic outdoor contexts (e.g., Haglund et al., 1988, 1989, 1993; Haglund, 1997a, b; Moraitis and Spiliopoulou, 2010) and archaeological contexts (e.g. Bindford, 1981; Brown et al., 2006; Haynes, 1980, 1982; Hill, 1979; Saladié et al., 2011; Selvaggio and Wilder, 2001). Scavenging includes the actions of all types of animals (terrestrial, avian and marine) on human and non-human remains that are left exposed either on the ground, in shallow graves or in marine environments (Sorg et al., 1997). Scavengers feed on any accessible carcasses, causing observable patterns of changes to the bones and specific distribution and dispersion of the remains.

According to their species and their dental anatomy, scavengers leave characteristic marks on the osseous remains (Dominguez-Solera and Dominguez-Rodrigo, 2009; Fisher, 1995; Haglund et al., 1988, 1989, 1997a, b; Knight, 1991; Lotan, 2000; Milner and Smith, 1989; Patel, 1994; Saladié et al., 2011; Willey and Lynn, 1989). Canids and especially dogs, for example, generally leave impressions or marks on bones, which have been identified and well defined by Haynes, Binford and Haglund (Bindford, 1981; Haglund, 1997a, b; Haynes, 1980). They are described as punctures and perforations (on flat bones and trabecular ends of long bones), pits (depressions into the cortical surface), furrows (longitudinal channels) and scoring (transverse scratches on long bone diaphyses). However, almost all carnivores may become scavengers depending on their circumstances and particularly in response to undernourishment stress (Brown et al., 2006).

Scavenging has several consequences in both bioarchaeology and forensic anthropology. In a forensic context, scavenging may leave postmortem alterations on bones that can be confused with antemortem lesions or cause simulation of antemortem wounds, destruction of key identification features and disorganisation of crime scenes (e.g., Moraitis and Spiliopoulou, 2010; Tsokos et al., 2010). In an archaeological context, scavenging may decrease the bone preservation and representation or combine various archaeological bone assemblages, due to extensive lesions and progressive body disarticulation (e.g., DeVault et al., 2003; Dominguez-Rodrigo, 2001; Haglund and Sorg, 2002; Hill, 1979).

We studied the skeletal remains of two individuals and some bovid bones buried in a pit. They came from the archaeological site of Duisans 'La Sèche-Epée' (Pas-de-Calais, France), dated from the 'La Tène A' period (500–400 BC).

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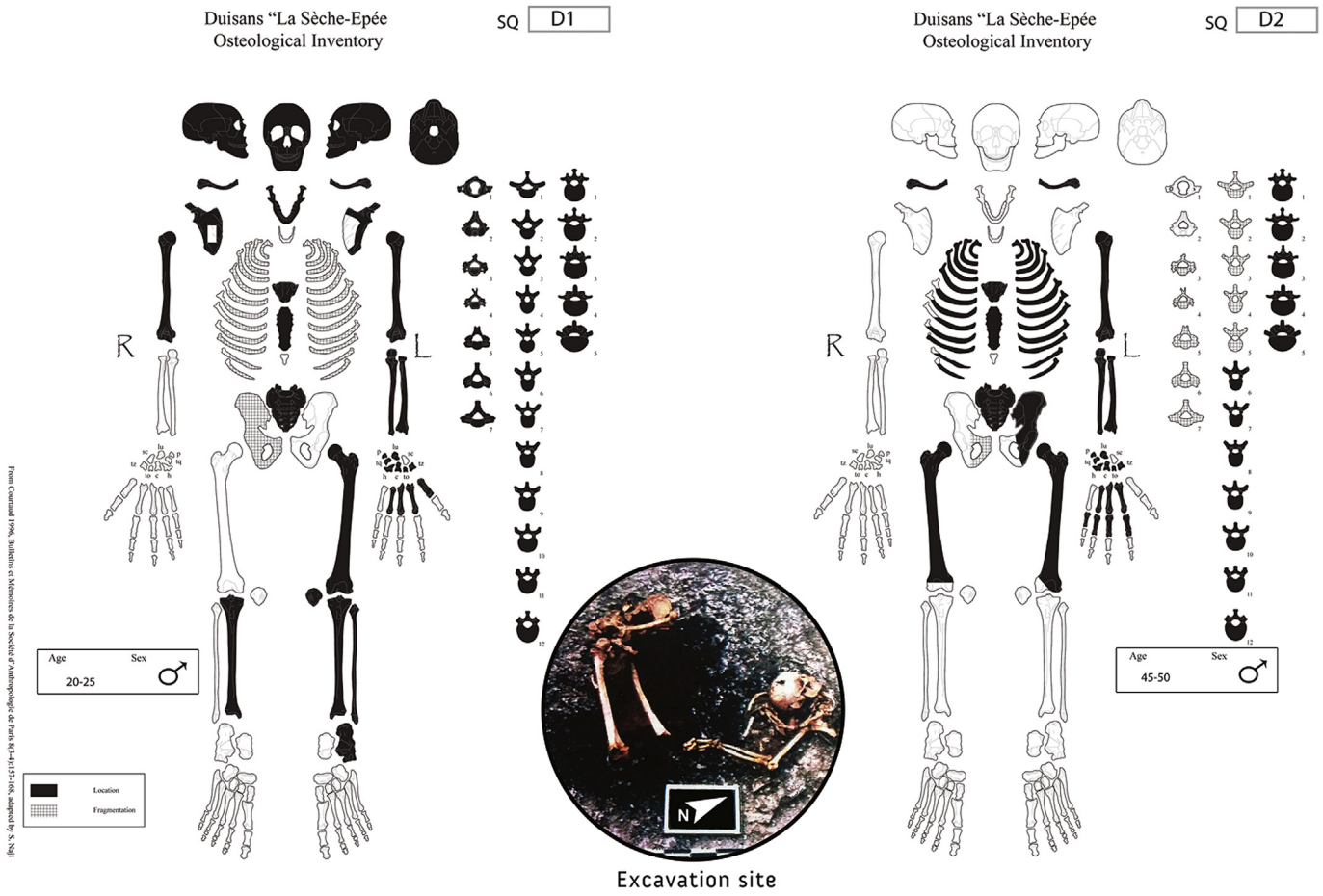

Fig. 1. Distribution of bones (in black) for D1 (left) and D2 (right). The inset shows a superior view of the pit.

Pit burials are part of a diverse set of Latenian funeral or mortuary practices documented in northern France, as well as in Britain (e.g., Carr and Knüsel, 1997; Wilson, 1981; Cunliffe, 1992; Debiak et al., 1998; Delattre et al., 2000; Fitzpatrick, 2010; Hill, 1995; Marion et al., 2010; Landolt et al., 2010; Madgwick, 2008). Outside cemeteries and isolated burials, human remains with or without animal bones were frequently deposited in pits. This sort of mortuary practice raises many questions: did pit burials have specific organisational rules, were they linked to ritual performances or were they used as abandoned places for relegation burials?

In this paper, we highlighted the utilisation of carnivore scavenging evidence found on both human and animal bones to refine the interpretation of this protohistoric French pit burial.

2. Materials and methods

2.1. Archaeological context

The site of Duisans 'La Seche-Epée' is located near Arras in the Scarpe Valley (northern France) and was excavated in 1996 by Alain Jacques. The site is composed of two pits on both sides of a trail dating from the Early Tène period, approximately 500 BC (Debiak et al., 1998). These pits were originally used for storage and later transformed into refuse dumps (Villes, 1987). The largest pit is 2.9 m in diameter and 1 m in depth, with an estimated volume of 6 m^3. It contained the skeletal remains of two individuals, D1 and D2, and fragmented remains of bovid bones.

Both human skeletons were incomplete and partially disarticulated. D1 was found lying face down at the bottom of the silo, with its cranium and mandible visible on its right side. Four vertebrae, the mandible and parts of the limbs were still articulated. D2 was found on its back, with the right femur connected to the pelvis (Fig. 1). All human and bovid bones presented periosteal polish and snake-like erosions caused by root etching (Quatrehomme and Iscan, 1997) (Fig. 2).

We used three indexes to document the state of preservation of those bones: the anatomic preservation index (API); the bone representation index (BRI); and the qualitative bone index (QBI), according to Bello et al. (2006). Outdoor postmortem exposition time was estimated using a model for stages of canid-scavenged disarticulation (Haglund, 1997a; Haynes, 1980, 1982; Hill, 1979). This method consists of evaluating the condition of the remains to estimate the postmortem interval in which canids could have access to the body.

2.2. 3D MSCT analysis

Multi-slice computed tomography (MSCT) acquisitions were performed using a Siemens Somatom Sensation 64 scanner and an Advantage Window Station (General Electric®), in the Musculoskeletal Radiology Department (Lille University Hospital). Scanning settings were as follows: slice thickness 0.6 mm, 120 Kv, 100 mA. Multiplanar reconstruction (MPR) and three-dimensional (3D) volume rendered analyses were performed using Osirix Imaging Software and 3D slicer (Open source DICOM Viewers). 3D surface

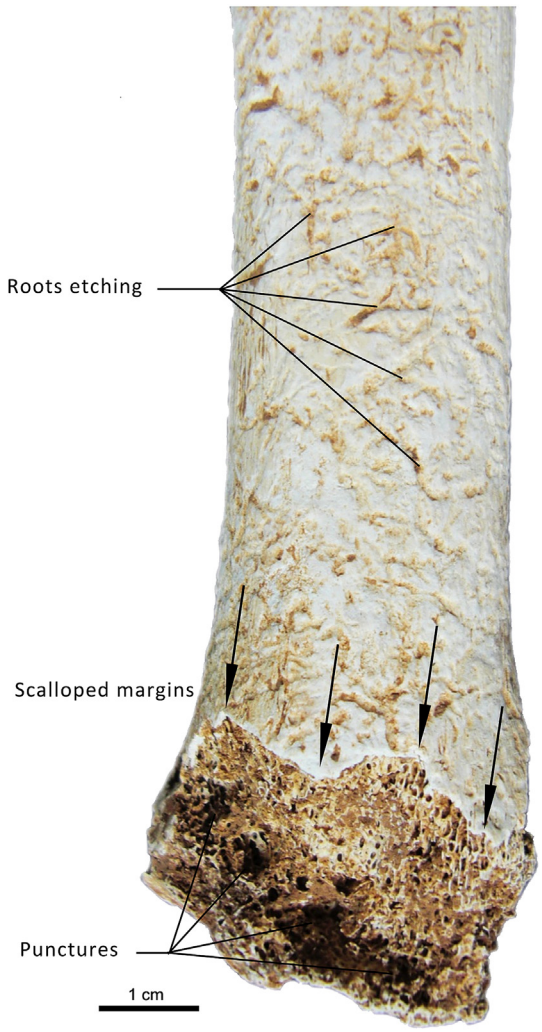

Fig. 2. Root etching on D1's right tibia diaphysis. Distal epiphysis shows scalloped margins and punctures.

models were obtained using Osirix Imaging Software and then exported to wavefront format (.obj).

MSCT analyses met three main objectives: analysing cortical and trabecular lesions using MPR; measuring volume, thickness and depth in axial, coronal and sagittal planes; and providing a 3D model to document and share the results.

2.3. Environmental scanning electron microscopy (ESEM)

Scanning electron microscopy (SEM) was conducted at 'Laboratoire d'Analyses Physiques et de Caractérisation des Matériaux, Direction de l'Archéologie Préventive, Communauté d'Agglomération du Douaisis'. Data were obtained with a Philips® ElectroScan 2020 equipped with Energy-Dispersive X-ray Spectroscopy (EDS). Examination of D1's humerus was performed at an original magnification of 400×. Bone surface was imaged using the secondary electron mode (GSED) of the ESEM, with beam parameters at a 15 keV accelerating voltage and 19 mm working distance.

3. Results

3.1. D1

Anthropological analysis revealed that D1 was a young (20–25 years old) slender male (Buikstra and Ubelaker, 1994; Murail et al., 2005). The skeleton was well-preserved (quantitatively and qualitatively), with all its bones, except the right coxa and costal cage, scoring class 5 (75%–99% of bone preserved) and class 6 (completely preserved) for API values, as well as QBI values. In addition, D1 was well-represented, as his BRI value was 67% (Bello et al., 2006).

D1 skeleton revealed several traumatic and taphonomic lesions.

3.1.1. Traumatic lesion

On the upper vertebral surface of the third lumbar vertebra, a 26-mm-long, 17-mm-wide and 10-mm-deep triangular perforation was found (Fig. 3A). The lack of healing and fracture margin remodelling indicated a perimortem wound. The particular lesion's morphology was typical of bladed instruments causing sharp-force or sharp-blunt trauma (i.e., stab wounds) (Kanz and Grossschmidt, 2006; Thali et al., 2003).

The lesion was isolated to create a specific region of interest (ROI) on each MSCT slice to obtain a specific 3D rendered volume

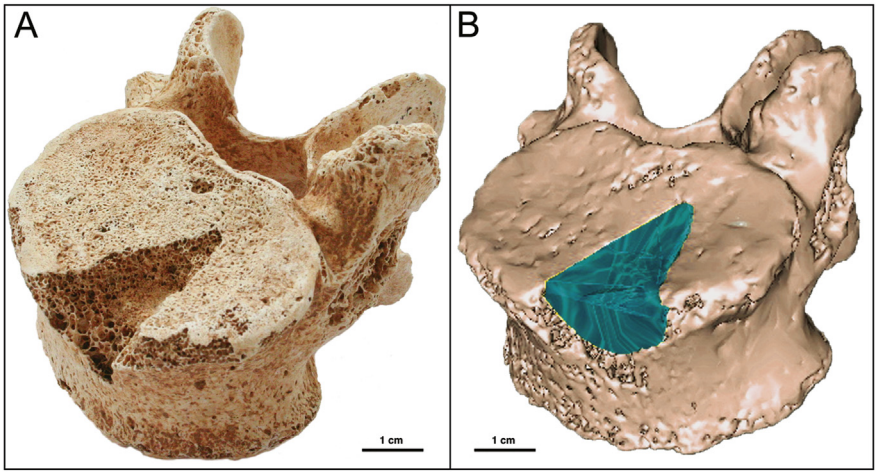

Fig. 3. Views of D2's third lumbar vertebra. A – Photograph showing a 26 mm long, 17 mm maximum width and 10 mm deep triangular perforation. B – Vertebra's 3D volume rendered image (3D MSCT interactive model available).

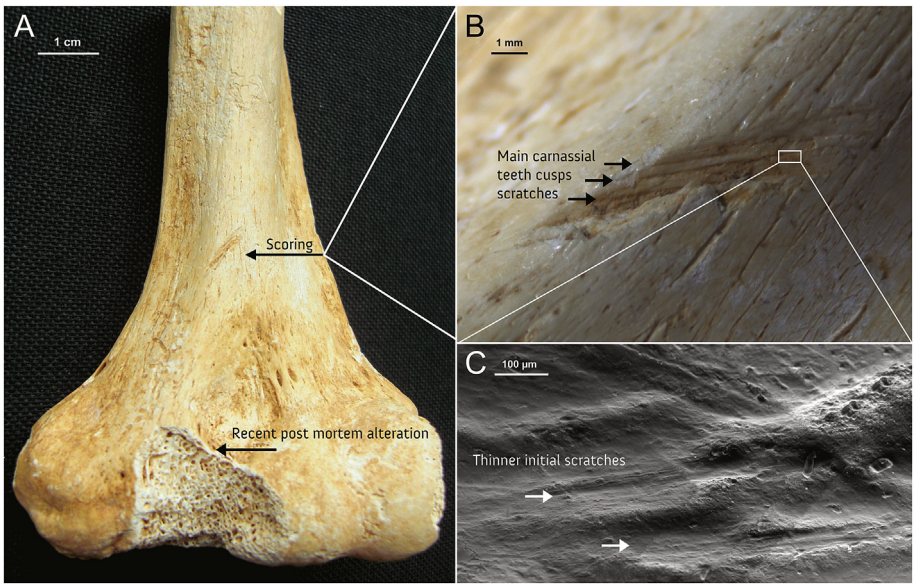

Fig. 4. A – Anterior view of D1's left humerus, with a 7.5 mm long and 1.5 mm wide oblique scoring on the medial supra-epicondylar crest (arrow). B – Binocular (Leica® L6D equipped with a digital camera Leica® DFC-280) view of the scoring showing three main scratches. C – ESEM analysis (400× magnification) showing thinner initial scratches.

(VOI) of the perforation. The VOI allowed us to obtain the volume, 0.923 cm^3, and the precise morphology of the blade tip (Fig. 3B, D MSCT model available).

3.1.2. *Scavenging lesions*

The medial supra-epicondylar crest of the left humerus showed an oblique scoring 7.5 mm long and 1.5 mm wide with a flat and smooth upper edge and a lower broken edge (Fig. 4A). Binocular analysis showed three main scratches in the deeper part of the lesion (Fig. 4B). ESEM analyses on the extremities of the lesion revealed several thinner scratches that could be produced when carnassial teeth cusps slip and drag over compact bone (Haglund, 1997a).

This specific morphology allowed us to link this lesion to a scavenger rather than a V-shaped blade trace with very clean walls and floor that would follow a linear course (Alunni-Perret et al., 2005).

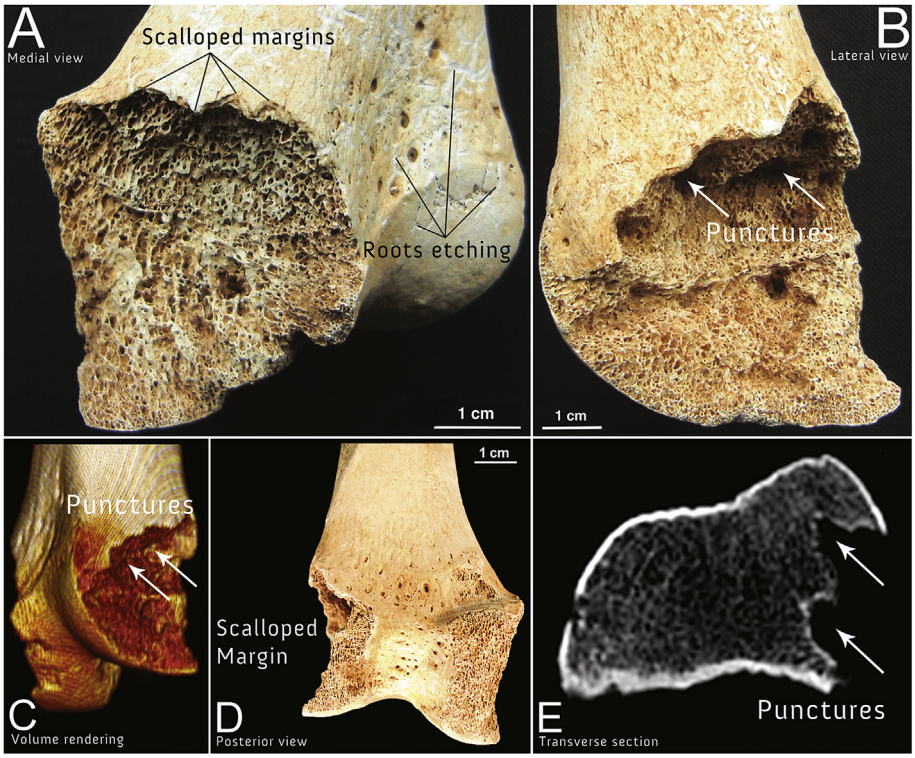

Fig. 5. D2's left femur, distal epiphysis. A – Lateral view of the left epicondyle and B – medial view of the right epicondyle, with several traces of indentations (punctures) and a chewed-like cortical area with scalloped margins. C – 3D volume rendered image (MSCT 3D interactive model available). D – Posterior view. E – CT cross-sectional image of distal epiphysis, with punctures (arrows).

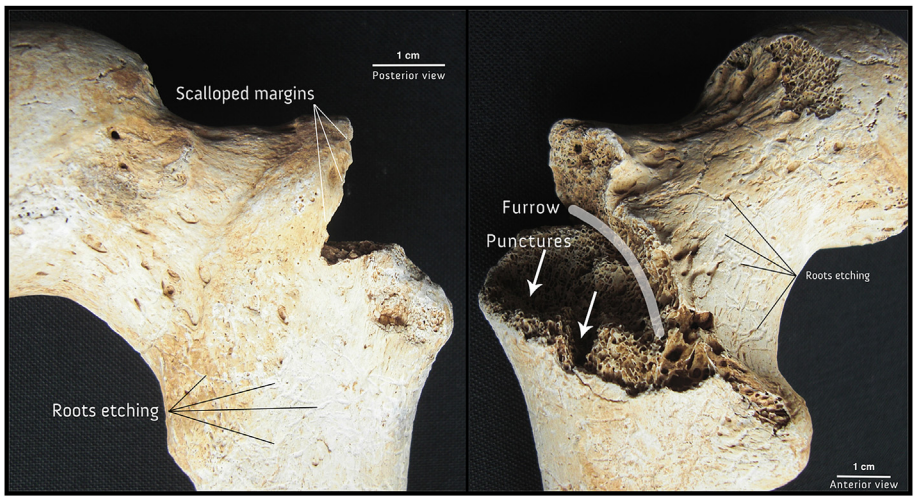

Fig. 6. Anterior (right) and posterior (left) views of D2's left femoral greater trochanter, partially destroyed and with a wide furrow in the trabecular bone and several punctures (MSCT 3D interactive model available).

The distal epiphysis of the right tibia showed typical canids marks: scalloped margins and four 2-mm deep punctures in the trabecular bone (Fig. 2).

3.2. D2

D2 was a mature male individual (45–50 years old), slightly more robust than D1 (Buikstra and Ubelaker, 1994; Murail et al., 2005). The D2 skeleton was poorly represented, with a BRI value of 40%. However, D2 was well-preserved (quantitatively and qualitatively), with all his bones, except the left coxa, scoring class 5 (75%–99% of bone preserved) and class 6 (completely preserved) for API and QBI values (Bello et al., 2006).

3.2.1. Scavenging lesions

The medial and lateral epicondyles and the greater trochanter of the left femur showed several traces of punctures in the trabecular bone, bordered by cortical bone with scalloped margins that resembled damage from chewing. The trabecular bone of the medial epicondyle was removed through eating, and half of the margin was scalloped. The lateral epicondyle showed ten marks of punctures and a fully scalloped margin (Figs. 5 and 3D MSCT model available). The greater trochanter was partially destroyed and showed a wide furrow in the trabecular bone (35 mm long, 5 mm wide, 5 mm deep) with four puncture marks and discrete scalloping of the cortical edge. The indentations measured 5–6 mm maximum in diameter and 4–5 mm maximum in depth (Figs. 6 and 3D MSCT model available). The distal epiphysis of the right femur showed an extensive destroyed surface bordered by a scalloped margin (Figs. 7 and 3D MSCT model available).

Finally, the left iliac wing exhibited three circular to oval puncture marks between 5 and 7 mm in diameter and 2–3 mm in depth (Fig. 8).

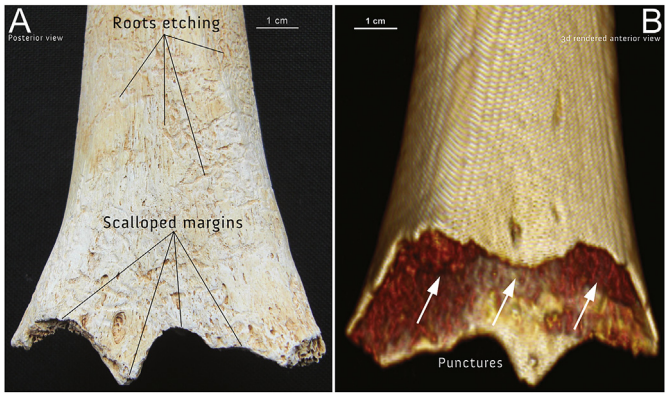

Fig. 7. D2's right femur, distal epiphysis. A – Anterior view showing an extensively destroyed surface bordered by a scalloped margin, and B – 3D volume rendered posterior view with punctures marks (MSCT 3D interactive model available).

4. Discussion

The discovery of two incomplete male skeletons in a pit raises several questions regarding the postmortem alteration of bodies and the associated lesions. In particular, how can the analysis of canid traces on bones help us interpret this sort of human remains deposit? What is the nature of such a site and its mortuary practice? Is it burial resulting from a ritual or the deposition of funeral-deprived and scavenged bodies in an abandoned pit?

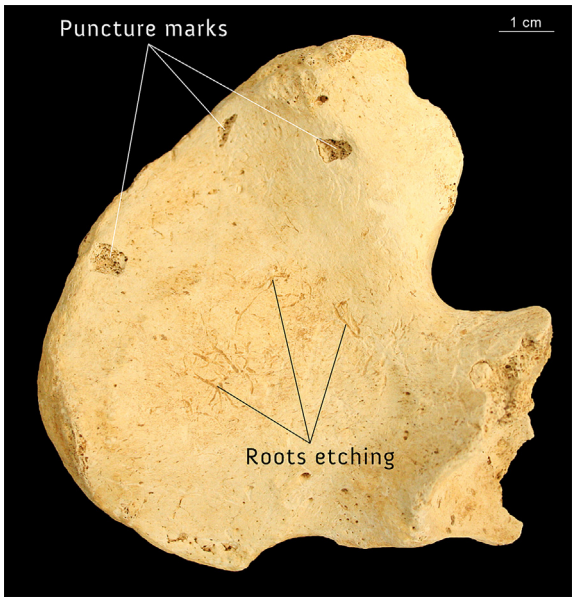

Fig. 8. Iliac wing presenting puncture marks and root etching.

4.1. Scavenging lesions

Several factors can influence the intensity of scavenging, including weather and body accessibility; however, the main motivation that drives carnivores to scavenge is hunger.

The scavenging process involved a decrease in the state of preservation and representation of osseous remains. The epiphysis of long bones, which are covered with a reduced amount of soft tissues, are the areas most affected by carnivore scavenging, resulting in the decreased preservation of those bones. Thus, the disarticulation process related to the scavenging, which affects the extremities for the most part, was responsible for a decreased representation of skeletal elements (Bello et al., 2006; Egeland et al., 2008; Faith and Berhensmeyer, 2006; Lyman, 1996; Milner and Smith, 1989).

D1's humerus and D2's femora and left ilium exhibit characteristic carnivore-type bite marks: scoring, punctures, furrows and chewed-like or scalloped cortical bones (Bindford, 1981; Haglund et al., 1988; Haynes, 1980, 1982; Milner and Smith, 1989). If we look at the detailed morphology and dimensions of these postmortem lesions, it is possible to attribute them to canidae, such as dogs, wolves or foxes. Canidae tend to leave bite marks characteristic of their species and their dental anatomy, which includes bevelled incisors, developed canine teeth (fangs) and fourth upper premolars and first lower molars that are referred to as carnassial teeth (Bindford, 1981; Haglund, 1997a; Haynes, 1980, 1982).

The lesions observed on both individuals included three distinct types corresponding to the mechanical characteristics of the affected anatomical area: thin and shallow scoring on the cortical bone (D1's left humerus), larger and deeper furrows on the trabecular bone (D2's left femur greater trochanter), and the most extreme 'scooped out' pattern (major trabecular bone removal through eating), which was observed on D2's left femoral epicondyles. Finally, we observed several punctures (indentations), but none of the much rarer complete perforations (Saladié et al., 2011). The dimensions of these indentations indicate a rather homogenous diameter and a lesser depth for the cortical bone (D2's ilium) compared with the trabecular bone (D2's left femur) for mechanical reasons. These dimensions implicate dogs among the possible local carnivores rather than foxes, which usually display smaller scavenging marks (Saladié et al., 2011; Selvaggio and Wilder, 2001). In addition, the size of the scalloped margins fits better with dogs' canine tooth pattern.

Other animals can cause similar lesions, notably rodents and suids (e.g., Haglund, 1997b; Greenfield, 1988; Western and Hurst, 2014). However, suidae preferentially use their incisors, creating long and flat tooth scores on bone surfaces; indentations are rarer, smaller and shallower (Dominguez-Solera and Dominguez-Rodrigo, 2009; Saladié et al., 2011).

In addition to the osseous lesions described above, scavenging led to the disarticulation of certain anatomical parts and the consequent disappearance of some bones, which explains the low representation of skeletal elements, particularly for D2 (BRI 40%).

Scavenging will progressively lead to full body disarticulation. This continuous process has been described as having several successive stages (Haglund et al., 1989, 1993; Haglund, 1997a; Hill, 1979; Lotan, 2000). Weather is important among the numerous variables that can modify the intensity of scavenging (Brown et al., 2006). We have thus used the Haglund et al. (1989) study, which took place in a similar climatic environment, to estimate the postmortem interval before the bodies were deposited into the pit. According to the condition of the remains (i.e., lower extremities fully or partially removed), both of the individuals are stage 2, which corresponds to a scavenging time of 2–4.5 months after death.

The bovid bones did not exhibit any scavenging lesions. This lack suggests that the bovid remains were not exposed outdoors with the human individuals, or at least, not at the same time and during the same period. However, almost all human and non-human bones presented etching lesions caused by roots. This taphonomic alteration had most likely occurred later, in the burial pit.

4.2. Nature of the deposit

The actual definition and identification of a burial as opposed to a deposit is central to our understanding of the Duisans site. A burial can be defined as 'a place consecrated by a funeral where the remains of one or several individuals have been deposited' (Boulestin and Duday, 2005). It is thus important to correctly identify each element of the definition for a robust interpretation. We have two individuals who were deposited in a pit, how can we assess the 'consecrated' or ritual element of the definition?

Pit deposits are well known in central and northern France during the La Tène period (Landolt et al., 2010; Marion et al., 2010). They have also been noted in southern England (Cunliffe, 1992; Fitzpatrick, 2010) and the Czech Republic (Knor, 1964). They are characterised by rare grave goods, the presence of animal bones, the unconventional position of the bodies and the presence of one or several individuals; the range of demographic profiles varies (Carr and Knüsel, 1997; Craig et al., 2005; Debiak et al., 1998; Delattre et al., 2000; Fitzpatrick, 2010; King, 2014; Madgwick, 2008; Rougier et al., 2007; Villes, 1987).

The debate in France focused on the idea of 'relegation' or deprivation of burial in connection with the status of the deceased or the manner of death (Delattre et al., 2000; Villes, 1987). In England, the main questions are about 'excarnation.' Voluntary and obviously artificial appearances suggest a social significance other than the abandonment of bodies or carcasses to scavengers. This treatment of the body by exposure is sometimes regarded to be the main practice during this period (Carr and Knüsel, 1997; Cunliffe, 1992; Fitzpatrick, 2010; Western and Hurst, 2014).

Both cases (D1 and D2) actually represent a good integration of these types of ritual gesture domains (propitiatory or funeral) or, conversely, their exclusion (e.g., Cunliffe, 1992; Delattre et al., 2000; Fitzpatrick, 2010; King, 2014).

At Duisans, bioarchaeological observations suggest a plausible death scenario and postmortem treatment for these two individuals. We can hypothesise that one of the individuals, D1, experienced a violent death, as illustrated by the perimortem and potentially lethal vertebral stab lesion. Their deaths may have occurred close in time, according to their similar canid-scavenged disarticulation stage; however, D2 had a lower bone representation index than D1 (40% versus 67%). These disarticulation stages also suggest that their bodies were exposed to open air and were accessible to scavengers for several months. This evidence thus suggests two secondary deposits, i.e., cadavers that had decomposed partially or fully in a temporary location and were deposited in a second, final resting place (the pit) at a later time (Duday, 2009). Exposition of the bodies to potential scavenging activity was either intentionally or accidentally interrupted when the bodies were deposited into the unused storage pit. Excavation revealed that the individuals seem to have been 'thrown' into the pit rather than carefully deposited, as suggested by their unusual positions. The closing of the pit followed rapidly, allowing some articulation to be maintained by sediment (Duday, 2009).

Even if this context is similar to several other sites described as 'relegation burials' (Delattre, 2000; Boulestin and Duday, 2005; Villes, 1987), two major differences should be noted: 1) the presence of carnivore marks, which are not described elsewhere in France, and 2) most of the other pits seem to host primary deposits,

which indicate burials in which individuals have been placed soon after death.

In France, the traditional interpretation of La Tène pit deposits has usually been linked to the social persona of the deceased; they have been described as 'deviants,' which can include slaves, criminals, prisoners or sacrifices (Villes, 1987). The same mortuary practices related to specific behaviours (e.g., head-hunting and execution) have been observed in Britain (Armit, 2012; Armit et al., 2013; Tucker and Armit, 2010). It is clear that during the La Tène period, the 'cemetery' was no longer the only burial place for the dead; bodies have also been found in isolated burials or within pits (Delattre et al., 2000; King, 2014; Marion et al., 2010). Numerous variations for the deposits have been described in the literature and have ranged from single articulated skeletons to multiple, commingled remains. Most of the time, in France, the body or body parts and eventually the bones are no longer available. Gestures preceding the burial are rarely discussed, and the complex workings of the burial are rarely detailed (Durand and Maçon, 2011). In England, organisational rules have been documented for burial pits, which indicate ritual performances, such as feasting (Cunliffe, 1992; Hill, 1995; Wilson, 1981). Animal depositions in pits are also described, sometimes sharing striking similarities, which may indicate shared similar symbolic identities (King, 2014).

The presence or absence of artefacts is random, as are the demographic parameters defining the buried sample, which varies from a heavy bias toward mature males to larger age distributions and different sex ratios (Durand and Maçon, 2011).

Discriminating and properly interpreting such deposits requires a bioarchaeological approach that considers all evidence, including archaeological artefacts, biological profiles, taphonomy, pathology and trauma. To date, taphonomical observations have been the most useful for understanding the chronology and organisation of the deposits. Durand and Maçon (2011), for example, clearly demonstrate solely through the sequences of skeletal disarticulation that the pit was used sequentially for a long period with diverse body management phases, resulting in a combination of primary and secondary deposits within the same structure. The only similarity among all the published archaeological contexts seems to be the association of one or several cadavers with a storage pit (Delattre et al., 2000). However, even though the presence of animal bones, food refuse and human cadavers within a pit is not systematic, their associations do not seem arbitrary (Villes, 1987). Delattre (2000) hypothesised that such associations can be interpreted within a symbolic funerary ritual context linked to fertility and crops, as opposed to the 'discarded' bodies of deviant individuals, if our preconceived perceptions of 'careful deposit' and 'refuse' are put into perspective.

If we consider this hypothesis in light of the evidence of the violent death and secondary treatment of the cadavers, Duisans can be interpreted as either an opportunistic votive burial or an actual sacrifice with a specific ritual pattern. Otherwise, Duisans falls into a more traditional deviant deposit tradition in which the individuals were deprived of funerals and exposed to scavengers before being discarded in an abandoned pit (Craig et al., 2005; King, 2014).

The research on seemingly similar contexts in Britain showed that the treatment suffered by animal and human skeletal remains was not the same. Exposure to external agents is evident in both cases, but scavenging seems to much more frequently affect faunal remains (Madgwick, 2008), while excarnation of the human body was rarer and perhaps more strictly controlled (Carr and Knüsel, 1997; Madgwick, 2008; Western and Hurst, 2014) before burial in old pits. However, traces of carnivorous contact appear on human remains in England, but are rarely found south of the Channel. Does this represent a real cultural difference or just a lack of data and knowledge? The interest in this type of human remains in recent years, regardless of the period, seems to go in the direction of cultural distinction, but only a systematic recovery of bones from the pits will enable a hypothesis.

The finding of such a similarity between Duisans and the south of England at the beginning of the second Iron Age is not surprising. Relationships between the two sides of the Channel and the sharing of cultural traits were well known in the Iron Age (e.g., Anthoons, 2011; Fitzpatrick, 2010). The remains of Duisans could be further evidence supporting this relationship.

5. Conclusion

Duisans pit burial is part of a wide range of Iron Age materials, belonging to several types of mortuary practices (pits, cemeteries, isolated burials, cremations, etc.). To properly document such diverse cultural practices, it is necessary, in addition to the archaeological analysis, to accurately and systematically describe all skeleton variations. A 'forensic' approach is thus warranted, particularly to identify traumatic events and taphonomic alterations.

The analysis of Duisans allowed us to document scavenging lesions from canidae. The morphology of these marks, which are sometimes similar to antemortem lesions (Ropohl et al., 1995), and the disarticulation and dispersal of anatomical parts are crucial elements that need to be precisely described and accounted for in archaeological or forensic contexts (Haglund, 1997c). To our knowledge, scavenging marks have not been reported in association with La Tène burial contexts in France, while the deposition of body parts is supported by the discovery of incomplete skeletons, making the site at Duisans a major additional piece of evidence in the study of Latenian funerary practices and in comparisons on both sides of the Channel.

Moreover, cause of death is rarely argued, usually preventing interpretation of such remains. Here, evidence of a violent death allows us to discuss the preburial treatment related to a non-natural death but without being able to draw conclusions because of the lack of pertinent comparisons. Duisans could be interpreted as a structured deposit resulting from ritual performance or sacrifice, or as a non-normative deviant deposit for individuals who were exposed to scavengers before being discarded in an abandoned pit. This argues for new, exhaustive studies of bone material from the pits of the La Tène period in the northern half of France.

Acknowledgements

Maxime Lemoine (Lille Forensic Medicine Institute), Benoit Bertrand and Lucille Géant (Laboratoire d'Analyses Physiques et de Caractérisation des Matériaux, Direction de l'Archéologie Préventive, Communauté d'Agglomération du Douaisis) for their precious help.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jas.2014.08.013.

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